EP 2 261 860 A1

FIG.1

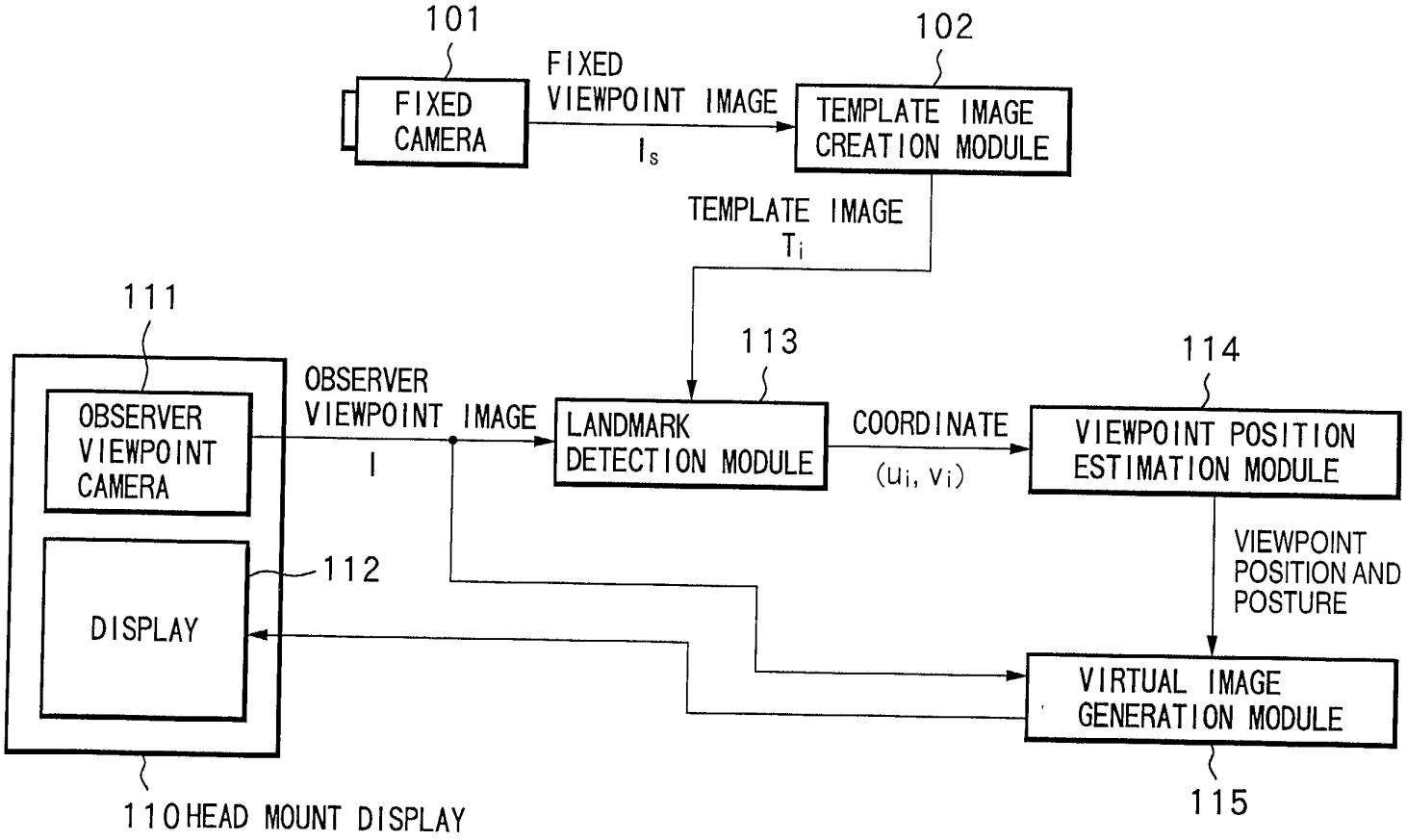

FIG.2

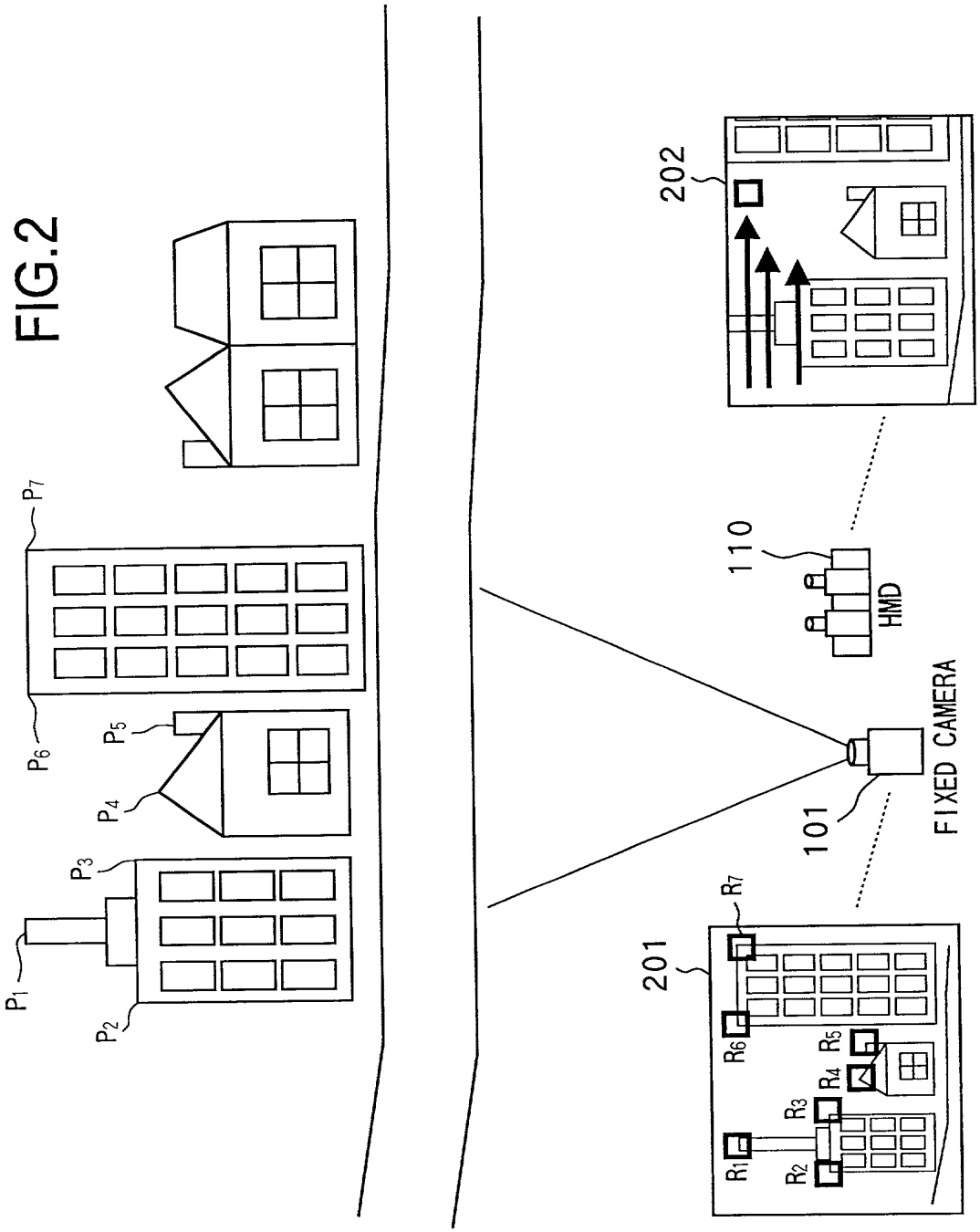
P1
P2
P3
P4
P5
P6
P7
201
R1
R2
R3
R4
R5
R6
R7
101
FIXED CAMERA
110
HMD
202

FIG.3

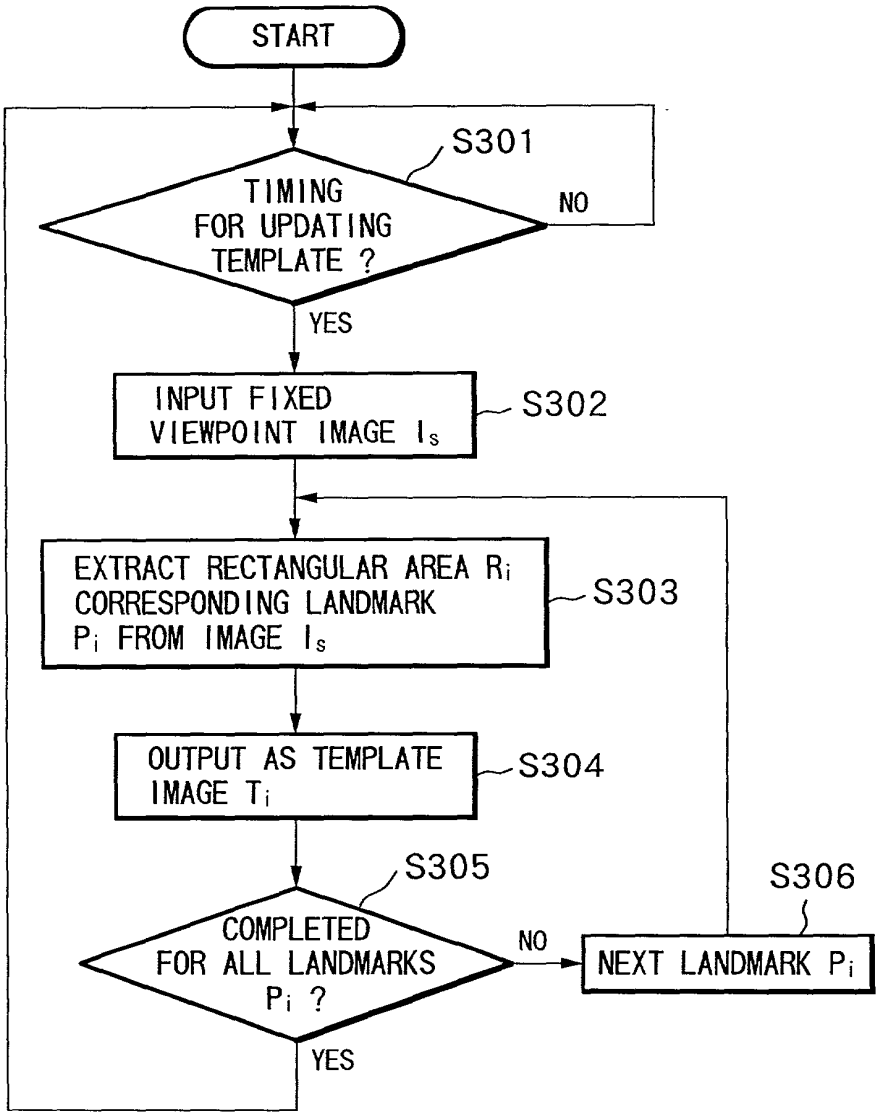
START
S301
TIMING FOR UPDATING TEMPLATE ?
NO
YES
INPUT FIXED VIEWPOINT IMAGE I_s
S302
EXTRACT RECTANGULAR AREA R_i CORRESPONDING LANDMARK P_i FROM IMAGE I_s
S303
OUTPUT AS TEMPLATE IMAGE T_i
S304
S305
COMPLETED FOR ALL LANDMARKS P_i ?
NO
S306
NEXT LANDMARK P_i
YES

FIG.4

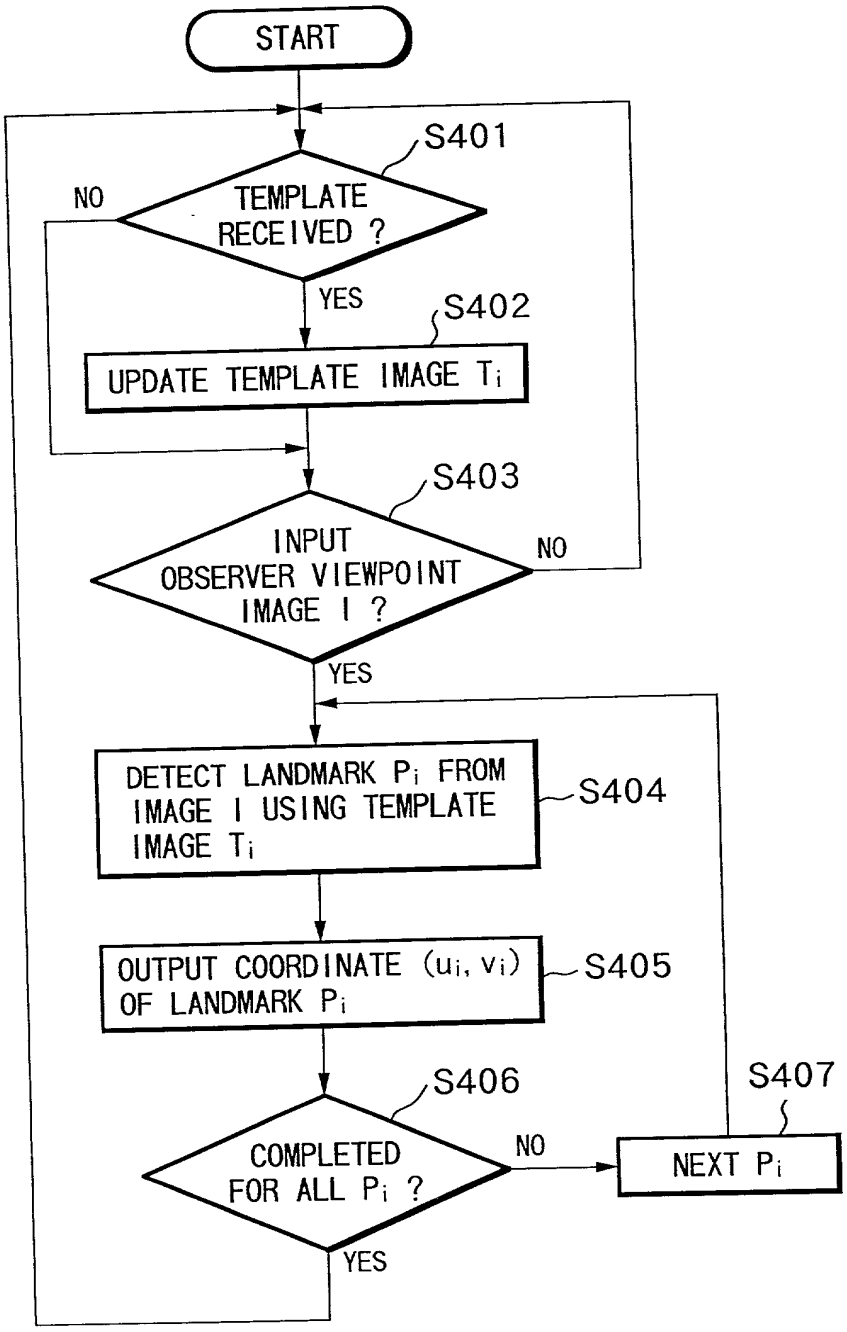
START
S401
TEMPLATE RECEIVED ?
NO
YES
S402
UPDATE TEMPLATE IMAGE Ti
S403
INPUT OBSERVER VIEWPOINT IMAGE I ?
NO
YES
DETECT LANDMARK Pi FROM IMAGE I USING TEMPLATE IMAGE Ti
S404
OUTPUT COORDINATE (ui, vi) OF LANDMARK Pi
S405
S406
COMPLETED FOR ALL Pi ?
NO
YES
S407
NEXT Pi

FIG.5A

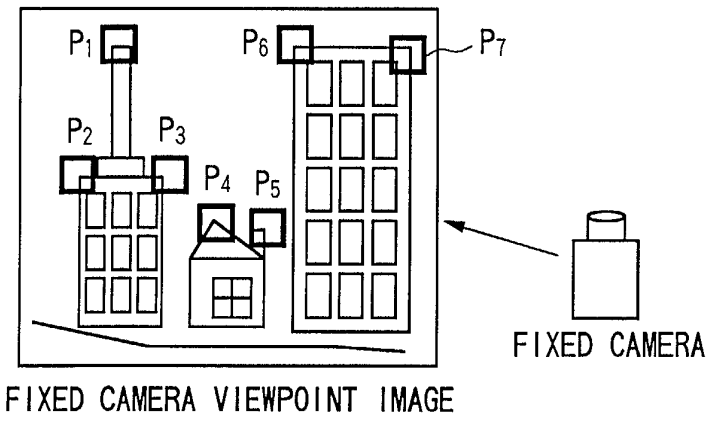
P1
P6
P7
P2
P3
P4
P5
FIXED CAMERA
FIXED CAMERA VIEWPOINT IMAGE

FIG.5B

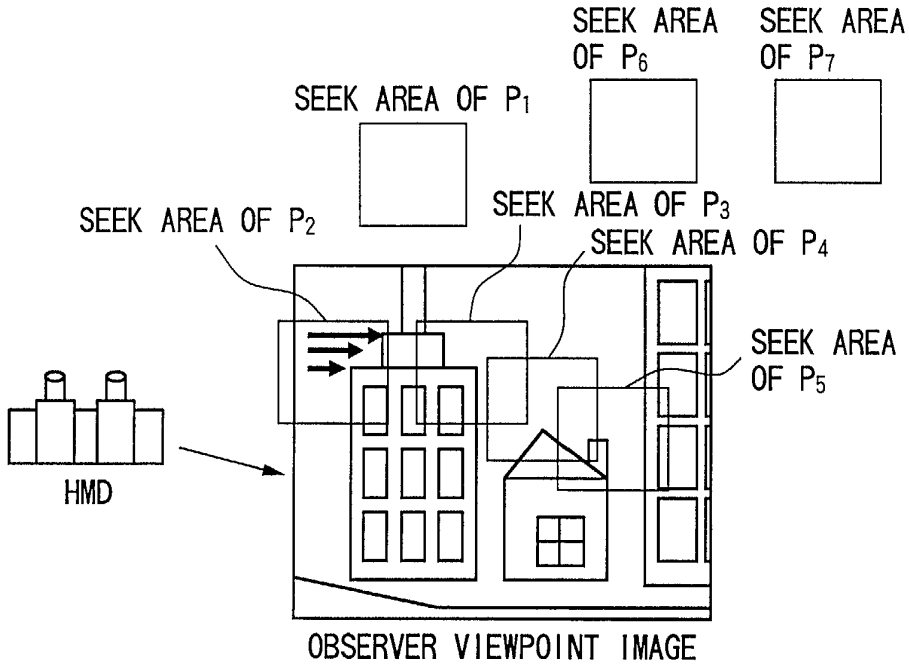
SEEK AREA OF P6
SEEK AREA OF P7
SEEK AREA OF P1
SEEK AREA OF P2
SEEK AREA OF P3
SEEK AREA OF P4
SEEK AREA OF P5
HMD
OBSERVER VIEWPOINT IMAGE

FIG.6

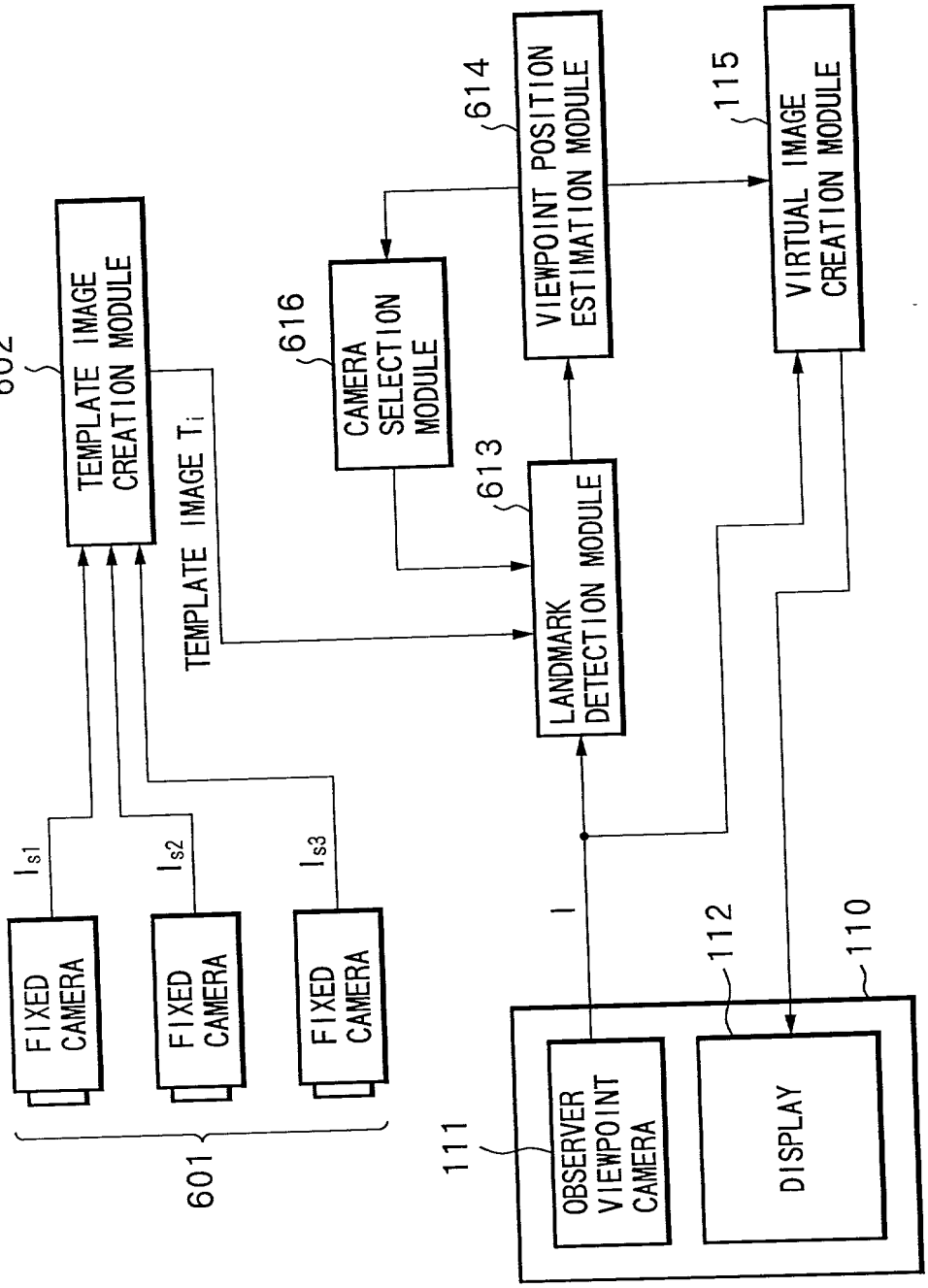
FIXED CAMERA
FIXED CAMERA
FIXED CAMERA
I_{s1}
I_{s2}
I_{s3}
601
602
TEMPLATE IMAGE CREATION MODULE
TEMPLATE IMAGE T_i
616
CAMERA SELECTION MODULE
613
LANDMARK DETECTION MODULE
614
VIEWPOINT POSITION ESTIMATION MODULE
115
VIRTUAL IMAGE CREATION MODULE
I
111
OBSERVER VIEWPOINT CAMERA
112
DISPLAY
110

FIG.7

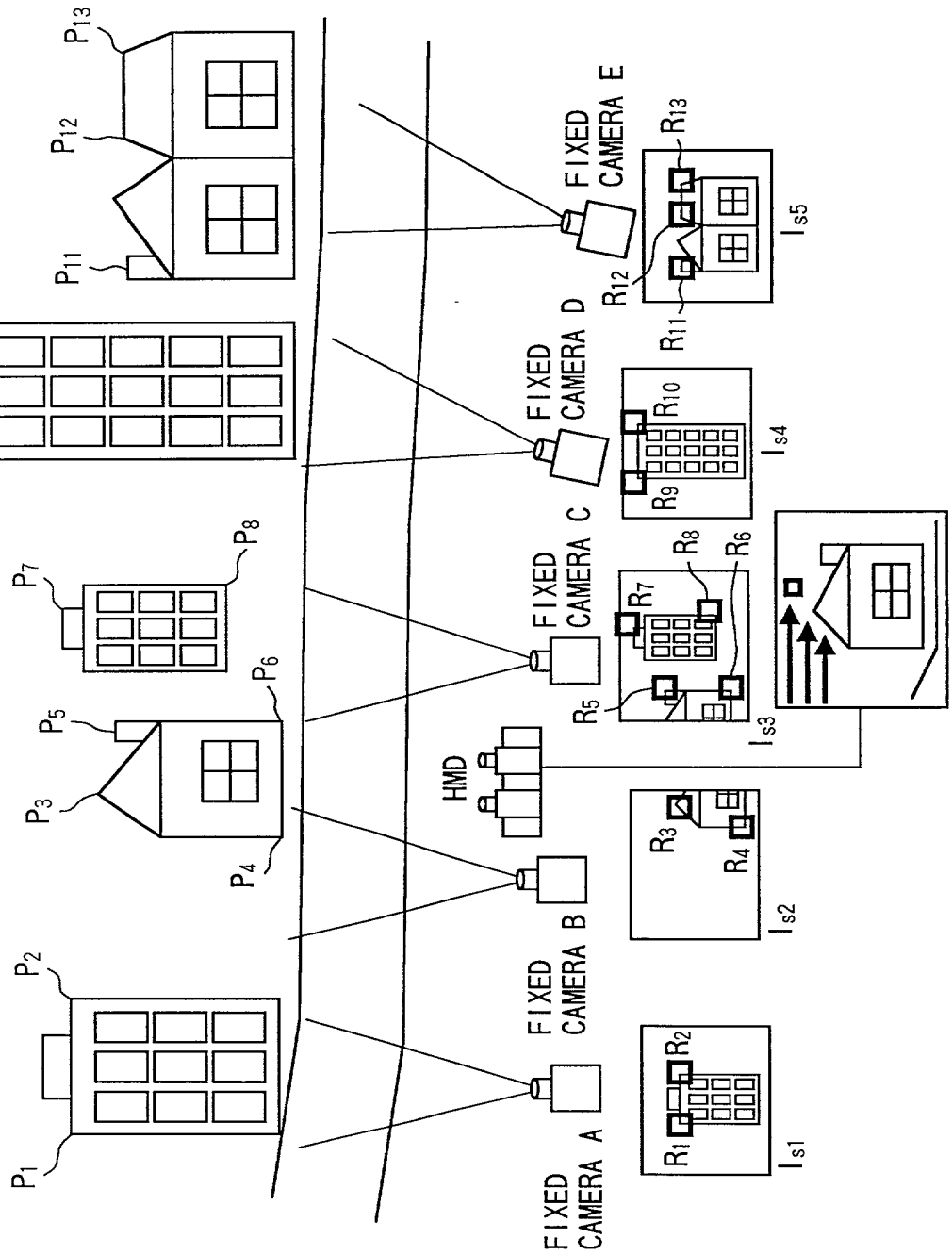
P1
P2
P3
P4
P5
P6
P7
P8
P9
P10
P11
P12
P13
FIXED CAMERA A
FIXED CAMERA B
FIXED CAMERA C
FIXED CAMERA D
FIXED CAMERA E
HMD
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
Is1
Is2
Is3
Is4
Is5

FIG.8

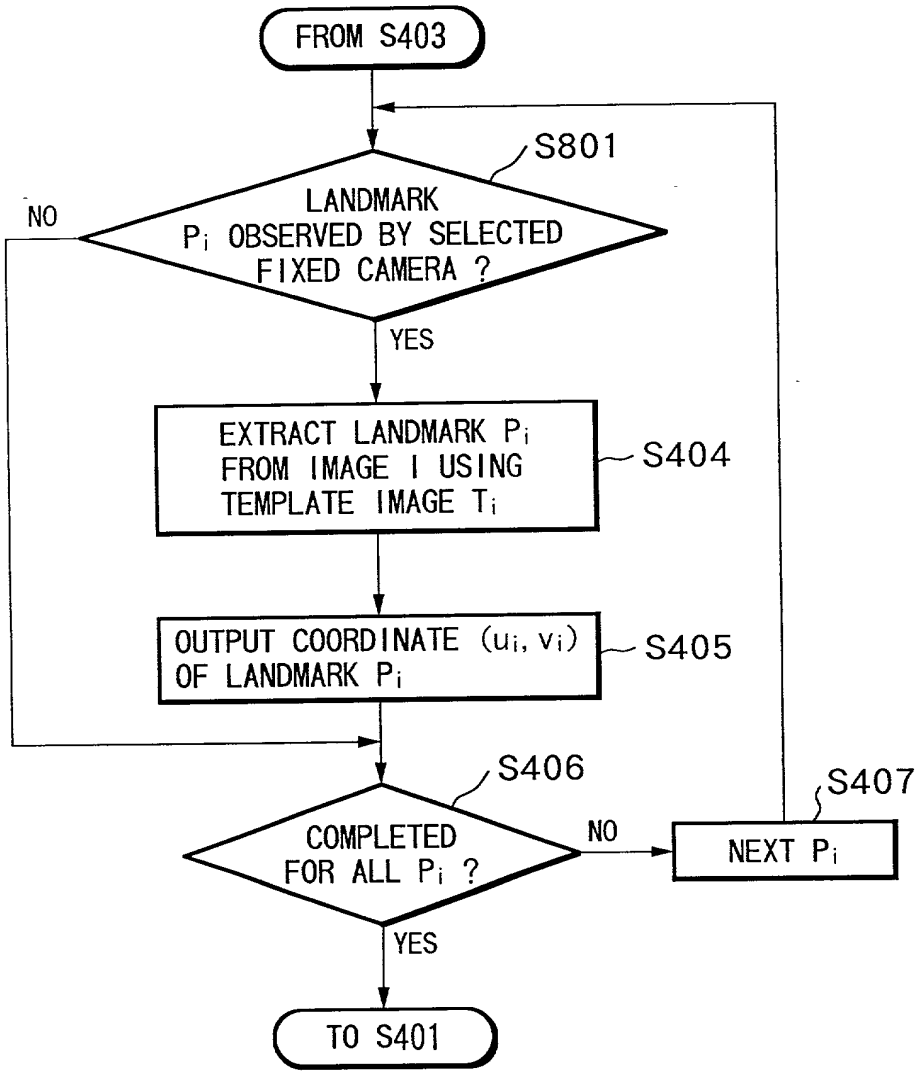
FROM S403
S801
LANDMARK P_i OBSERVED BY SELECTED FIXED CAMERA ?
NO
YES
EXTRACT LANDMARK P_i FROM IMAGE I USING TEMPLATE IMAGE T_i
S404
OUTPUT COORDINATE (u_i, v_i) OF LANDMARK P_i
S405
S406
COMPLETED FOR ALL P_i ?
NO
S407
NEXT P_i
YES
TO S401

FIG.9

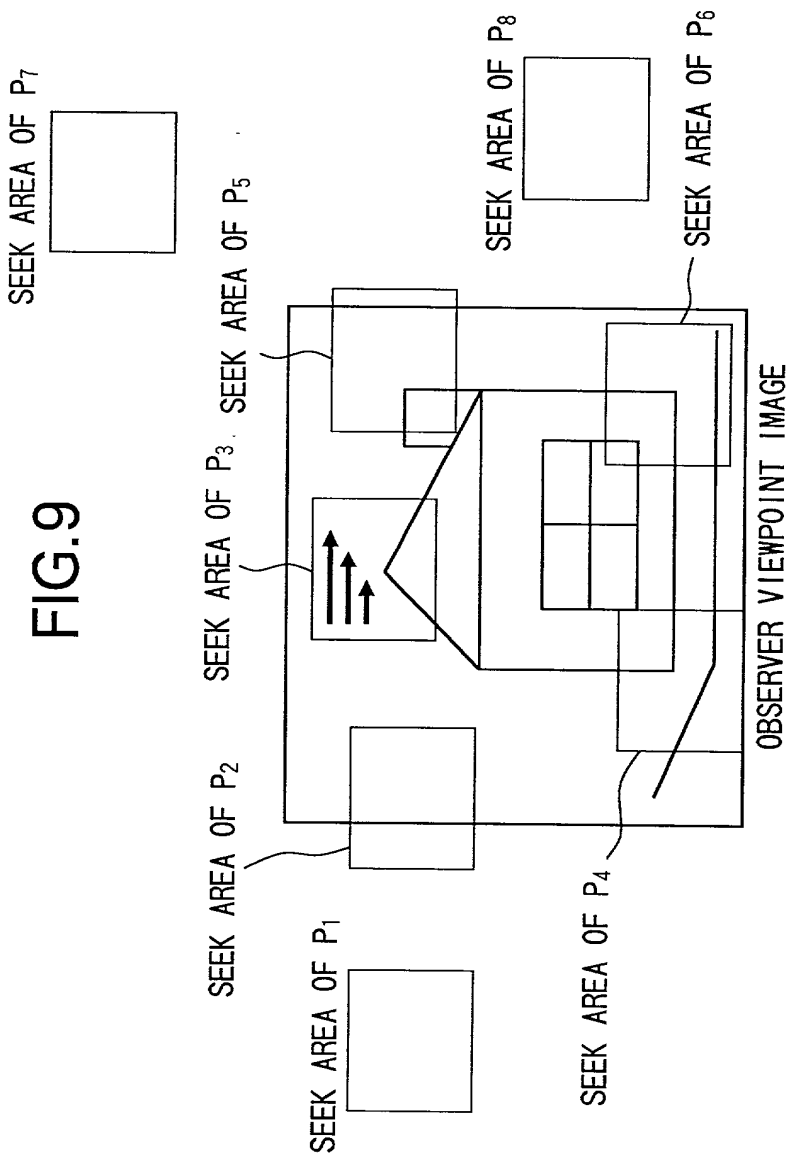
SEEK AREA OF P7
SEEK AREA OF P5
SEEK AREA OF P8
SEEK AREA OF P6
SEEK AREA OF P3
SEEK AREA OF P2
OBSERVER VIEWPOINT IMAGE
SEEK AREA OF P1
SEEK AREA OF P4

FIG.10

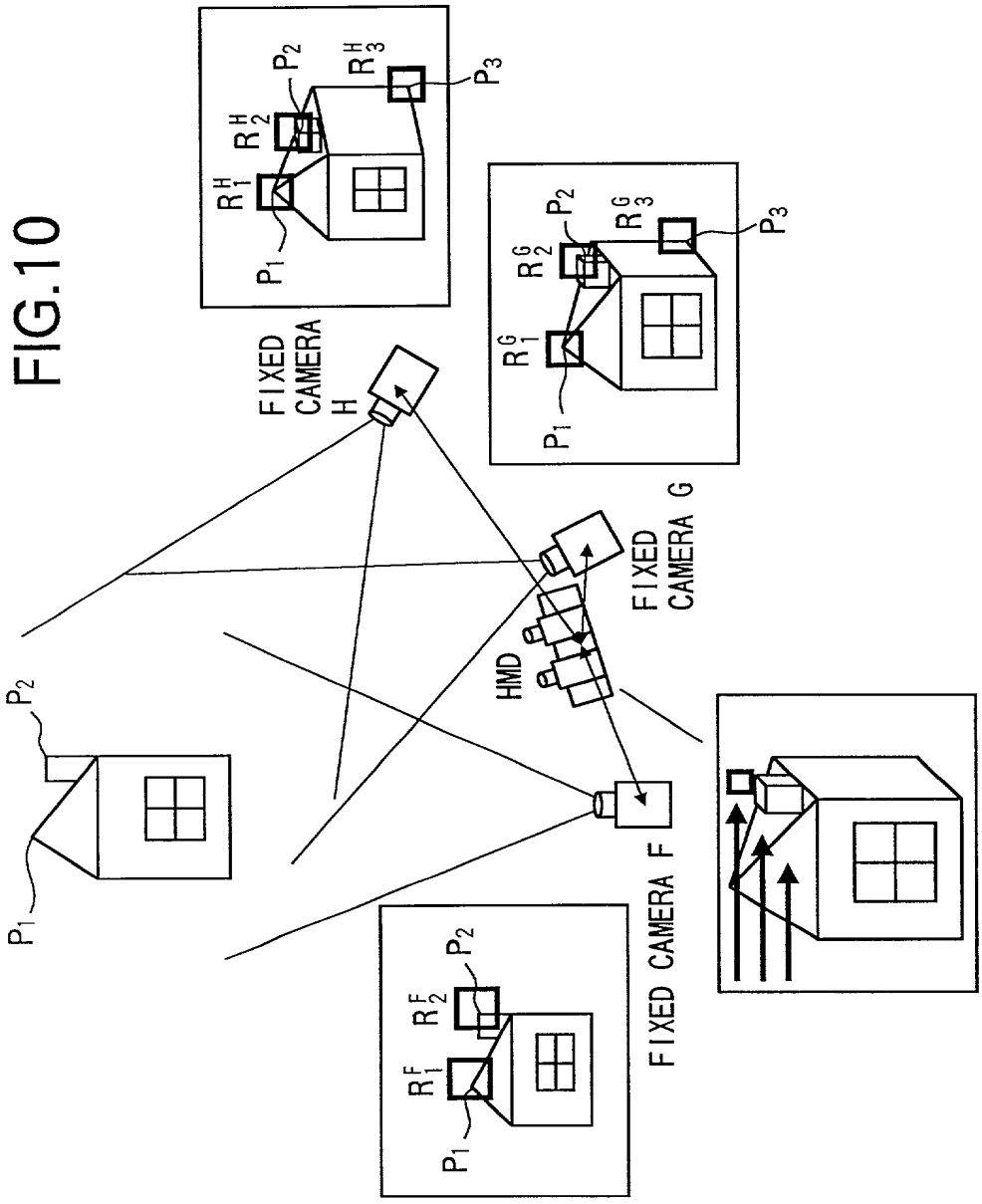

FIG.11

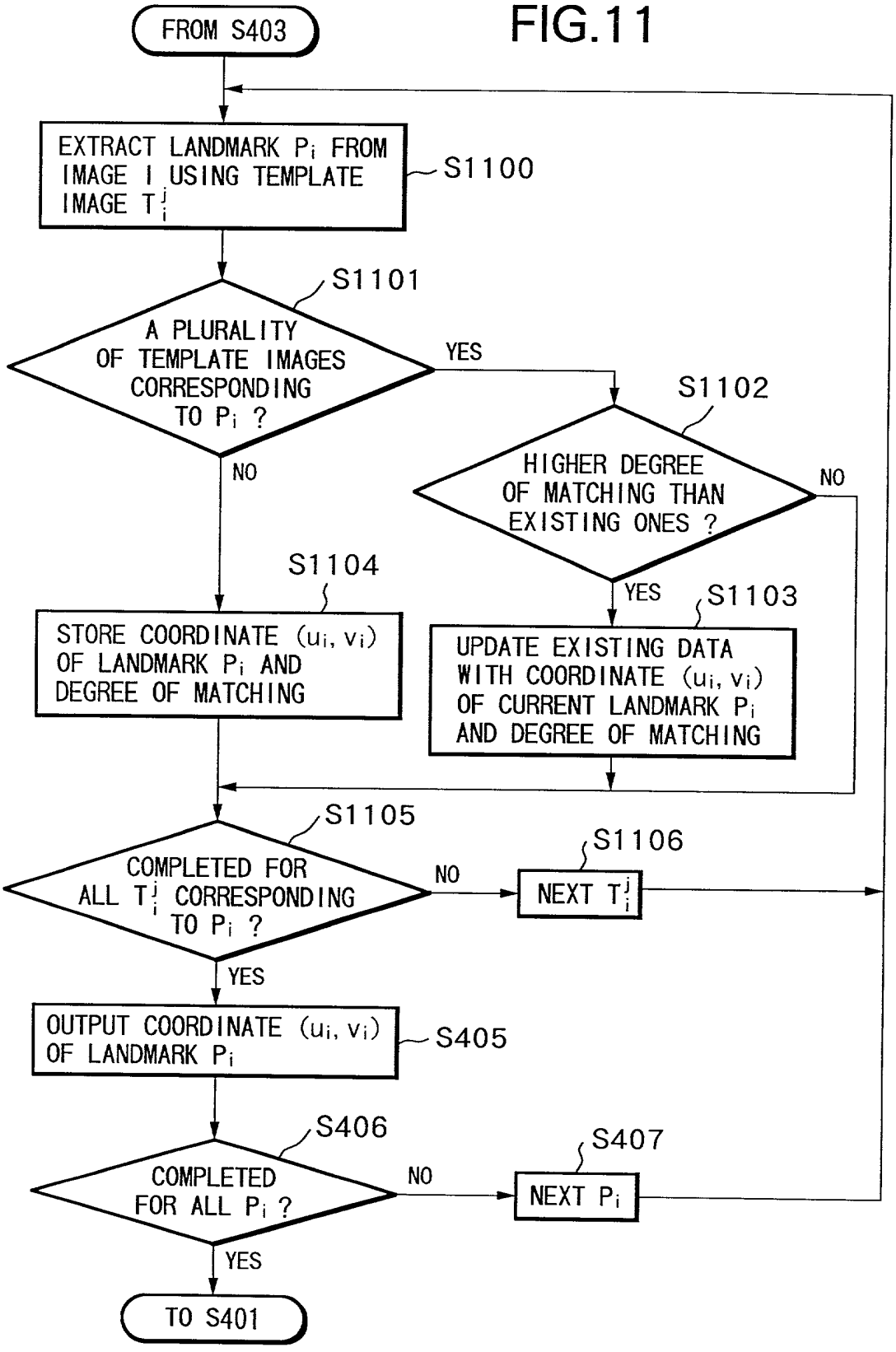
FROM S403
EXTRACT LANDMARK Pi FROM IMAGE I USING TEMPLATE IMAGE T_i^j
S1100
S1101
A PLURALITY OF TEMPLATE IMAGES CORRESPONDING TO Pi ?
YES
NO
S1102
HIGHER DEGREE OF MATCHING THAN EXISTING ONES ?
NO
YES
S1103
UPDATE EXISTING DATA WITH COORDINATE (ui, vi) OF CURRENT LANDMARK Pi AND DEGREE OF MATCHING
S1104
STORE COORDINATE (ui, vi) OF LANDMARK Pi AND DEGREE OF MATCHING
S1105
COMPLETED FOR ALL T_i^j CORRESPONDING TO Pi ?
NO
S1106
NEXT T_i^j
YES
OUTPUT COORDINATE (ui, vi) OF LANDMARK Pi
S405
S406
COMPLETED FOR ALL Pi ?
NO
S407
NEXT Pi
YES
TO S401

FIG.12

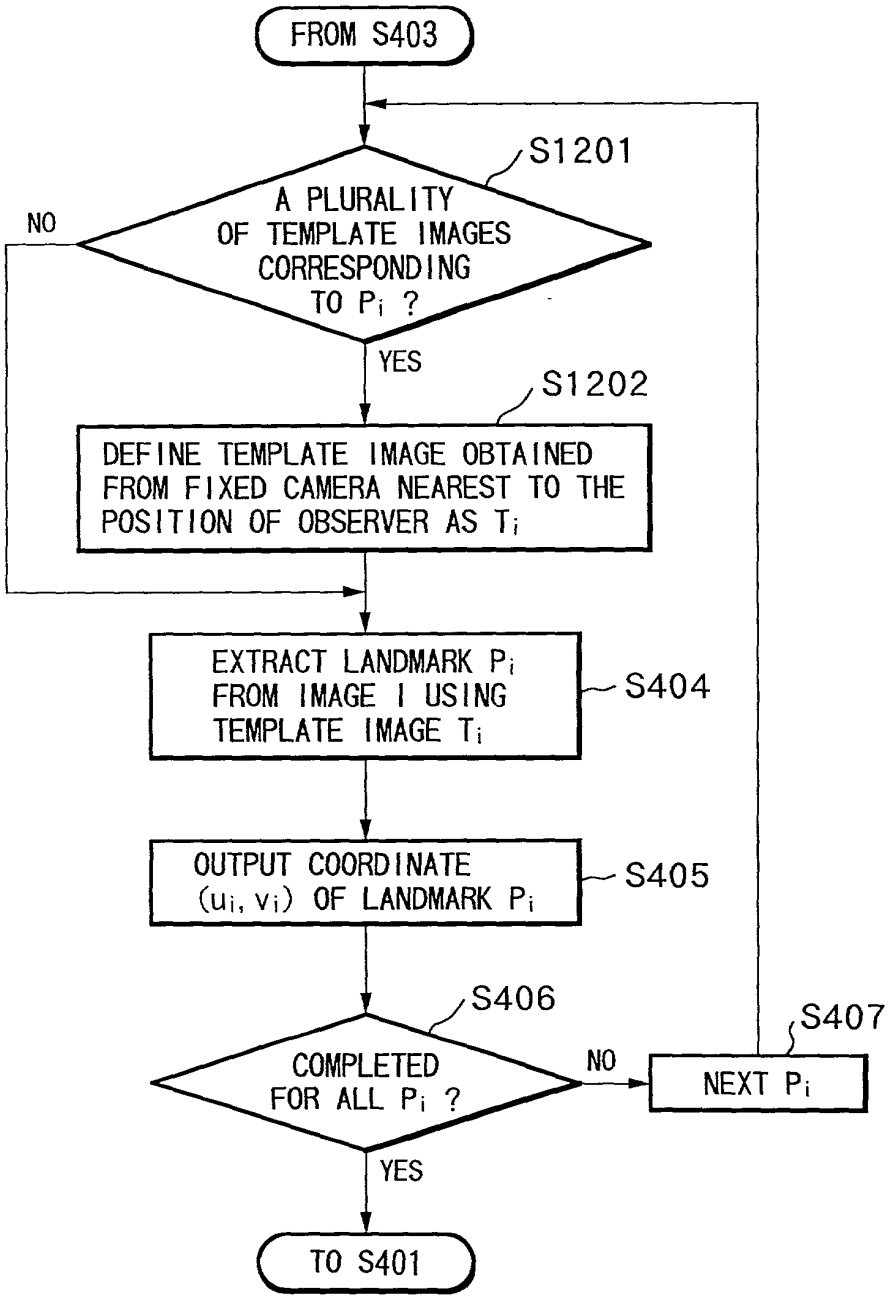
FROM S403
S1201
A PLURALITY OF TEMPLATE IMAGES CORRESPONDING TO P_i ?
NO
YES
S1202
DEFINE TEMPLATE IMAGE OBTAINED FROM FIXED CAMERA NEAREST TO THE POSITION OF OBSERVER AS T_i
EXTRACT LANDMARK P_i FROM IMAGE I USING TEMPLATE IMAGE T_i
S404
OUTPUT COORDINATE (u_i, v_i) OF LANDMARK P_i
S405
S406
COMPLETED FOR ALL P_i ?
NO
S407
NEXT P_i
YES
TO S401

FIG.13A

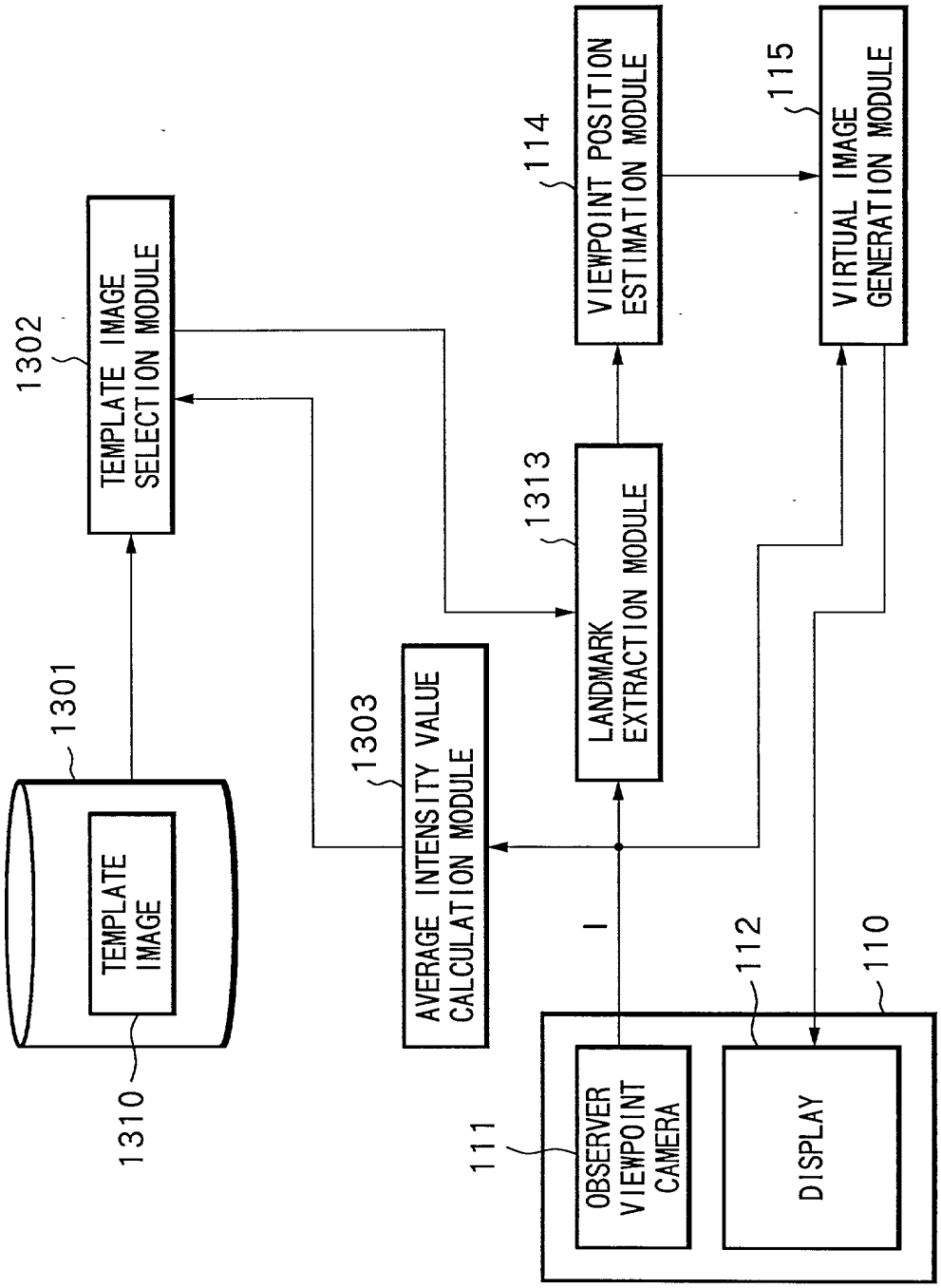
TEMPLATE IMAGE SELECTION MODULE
1302
TEMPLATE IMAGE
1301
1310
AVERAGE INTENSITY VALUE CALCULATION MODULE
1303
LANDMARK EXTRACTION MODULE
1313
VIEWPOINT POSITION ESTIMATION MODULE
114
VIRTUAL IMAGE GENERATION MODULE
115
I
OBSERVER VIEWPOINT CAMERA
111
DISPLAY
112
110

FIG.13B

	INTENSITY RANGE A	INTENSITY RANGE B	INTENSITY RANGE C	
LANDMARK #1	T_{1A}	T_{1B}	T_{1B}	
LANDMARK #2	T_{2A}	T_{2B}	T_{2C}	
LANDMARK #3	T_{3A}	T_{3B}	T_{3C}	

1310
TEMPLATE IMAGE

FIG.14

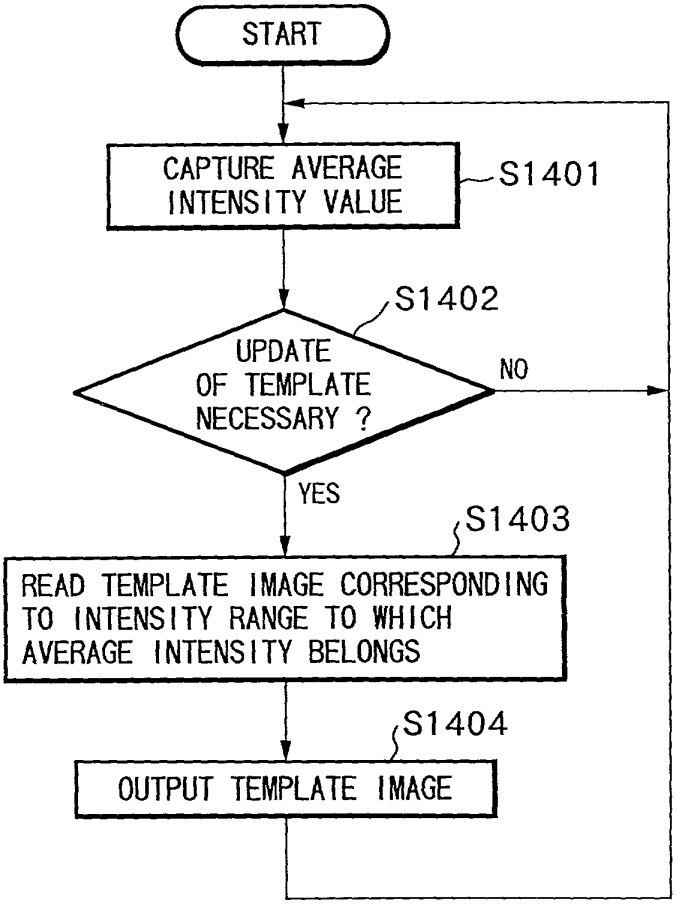
START
CAPTURE AVERAGE INTENSITY VALUE
S1401
S1402
UPDATE OF TEMPLATE NECESSARY ?
NO
YES
S1403
READ TEMPLATE IMAGE CORRESPONDING TO INTENSITY RANGE TO WHICH AVERAGE INTENSITY BELONGS
S1404
OUTPUT TEMPLATE IMAGE

FIG.15

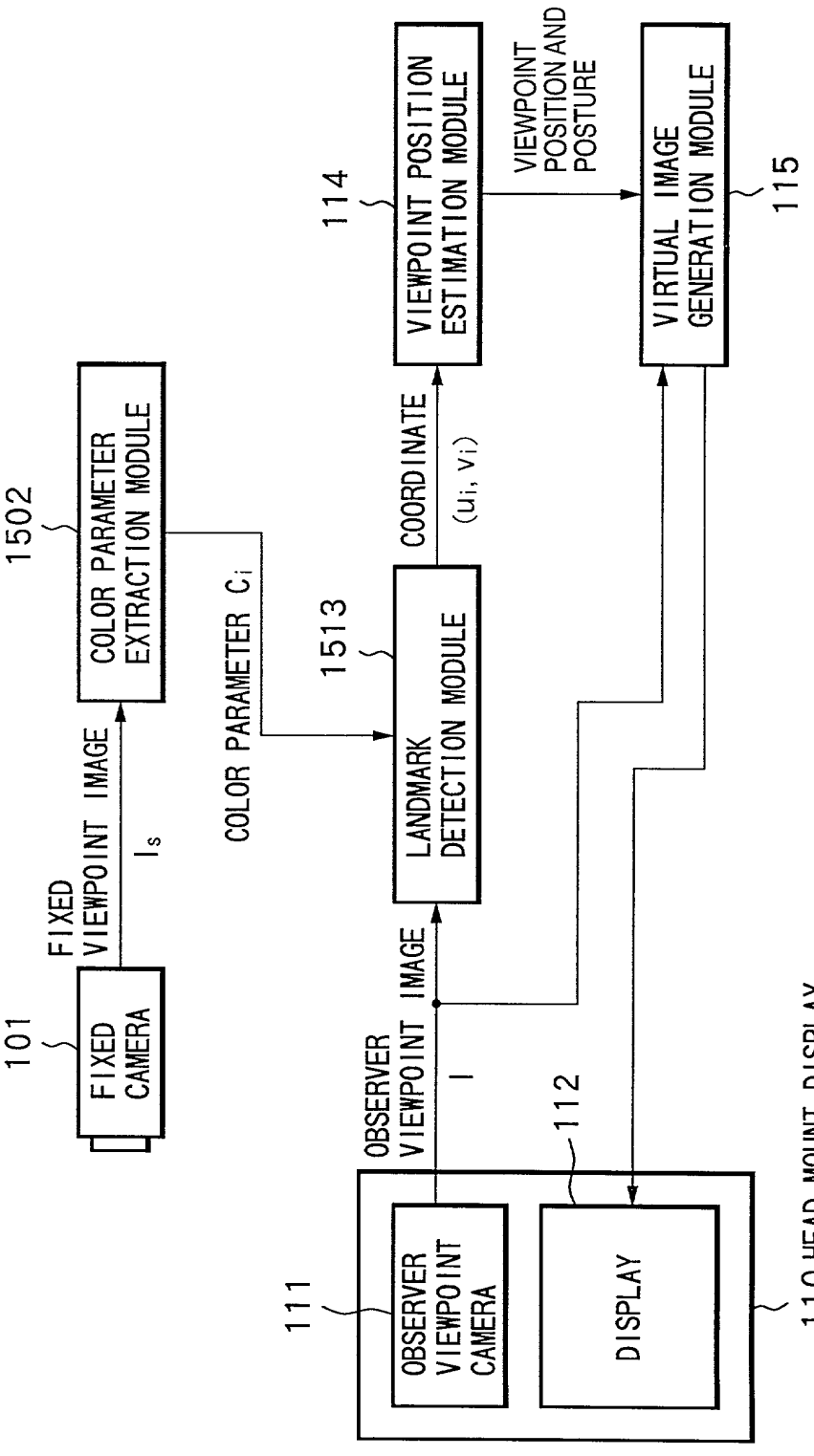
101
FIXED CAMERA
FIXED VIEWPOINT IMAGE
I_s
1502
COLOR PARAMETER EXTRACTION MODULE
COLOR PARAMETER c_i
1513
LANDMARK DETECTION MODULE
COORDINATE
(u_i, v_i)
114
VIEWPOINT POSITION ESTIMATION MODULE
VIEWPOINT POSITION AND POSTURE
115
VIRTUAL IMAGE GENERATION MODULE
OBSERVER VIEWPOINT IMAGE
I
111
OBSERVER VIEWPOINT CAMERA
112
DISPLAY
110 HEAD MOUNT DISPLAY

FIG.16

CAMERA F		CAMERA G		CAMERA H	
LANDMARK	TEMPLATE IMAGE	LANDMARK	TEMPLATE IMAGE	LANDMARK	TEMPLATE IMAGE
P_1	T^F_1	P_3	T^G_3	P_7	T^H_7
P_2	T^F_2	P_4	T^G_4	P_8	T^H_8
P_3	T^F_3	P_5	T^G_5	P_9	T^H_9
P_4	T^F_4	P_6	T^G_6	P_{10}	T^H_{10}
P_5	T^F_5	P_7	T^G_7	P_{11}	T^H_{11}
P_6	T^F_6	P_8	T^G_8	P_{12}	T^H_{12}